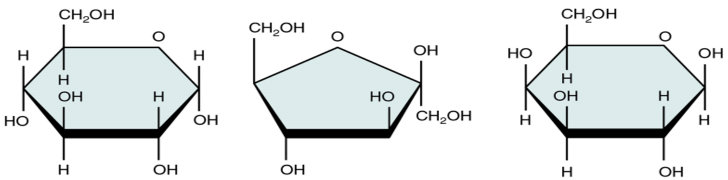
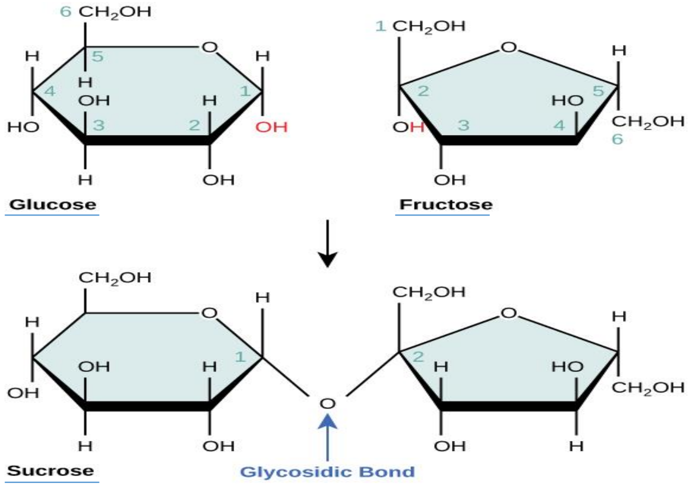
A-Level Carbohydrates part 1

Monosaccharides are the **monomers** from which larger carbohydrates are made. Glucose, fructose and galactose are monosaccharides.



Two monosaccharides can join together to form a **disaccharide**. This process involves the removal of a water molecule (red atoms) in a **condensation reaction** and the formation of a **glycosidic** bond.



Monosaccharides	Disaccharide
glucose + glucose	maltose
glucose + fructose	Sucrose (see above)
glucose + galactose	lactose

Water can be added to hydrolyse a disaccharide and break the glycosidic bond (**hydrolysis reaction**).

Testing for reducing sugars – Benedict's test

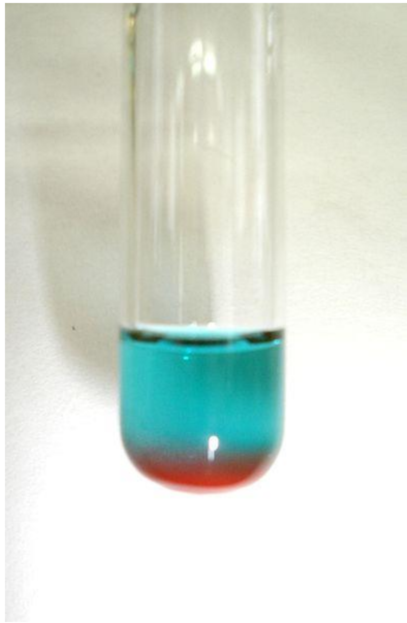
All monosaccharides are **reducing sugars**: they reduce Benedict's solution (copper (II) sulphate) when **heated**. Cu^{2+} ions are reduced to Cu^{+} ions, forming a **brick-red** precipitate of copper (I) oxide. In a **negative result**, the solution remains **blue**.

The Benedict's test provides a **semi-quantitative** measure of the amount of reducing sugar present shown by the colour of solution and precipitate:

blue → green → yellow → brown → red

increasing quantity of reducing sugar

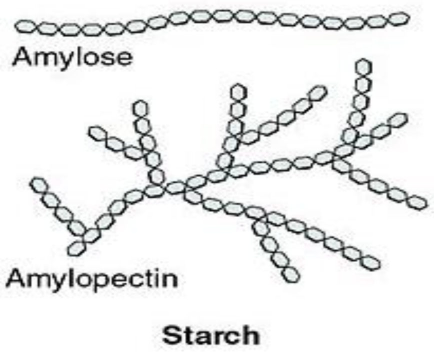
Some disaccharides (e.g. sucrose) are **non-reducing sugars**. The functional group which donates electrons from the constituent monosaccharides are involved in the formation of the glycosidic bond and so the disaccharide has no reducing ability. **Maltose** and **lactose** are examples of disaccharides that are reducing sugars.



Polysaccharides are formed by the condensation of many glucose units.

Starch is a **storage polysaccharide** found extensively in plants. It is made up of a mixture of **amylose** and **amylopectin** molecules.

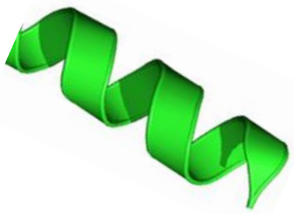
Amylose is made of straight chains of **α-glucose.**
Amylopectin is made of branched chains of **α-glucose.**



The branched structure of amylopectin makes starch **compact** and **insoluble** and so ideal for storing energy provided by the glucose molecules.

Starch is an important **energy source in animals** and the branched nature of amylopectin means it can be **rapidly hydrolysed** to release energy.

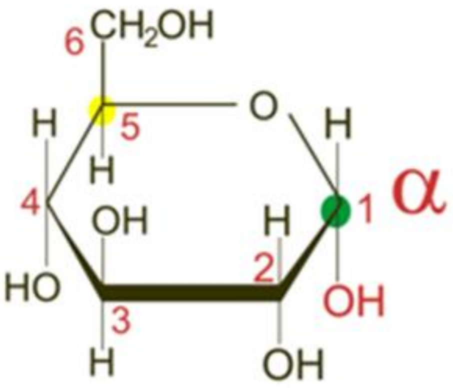
Testing for Starch



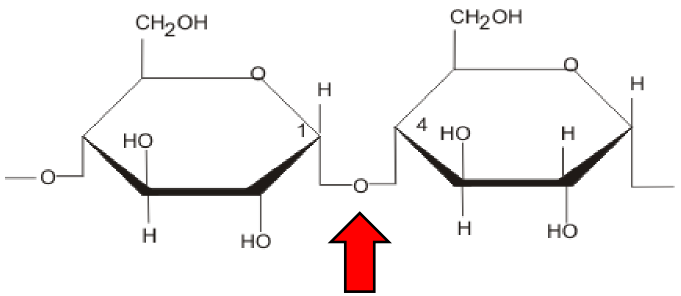
Iodine in **potassium iodide** is used to test for starch. The α - glucose in both amylose and amylopectin form a helix. The iodine molecules fit into the centre of the helix, creating a **blue-black colour**.

A-Level Carbohydrates part 2

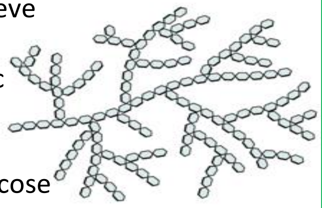
Polysaccharides are formed by the condensation of many glucose units.
Glycogen and starch are **storage** polysaccharides made up of **α-glucose** which has a 'down' OH group on both carbon 1 and carbon 4.



This allows glycosidic bonds to form using these hydroxyl groups and so the bond is called a **1,4 glycosidic bond**.



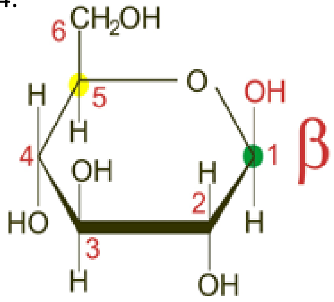
Glycogen is a highly branched polymer found in liver and muscles. To achieve this branching, glycogen has 1,4 glycosidic bonds **AND** 1,6 glycosidic bonds.



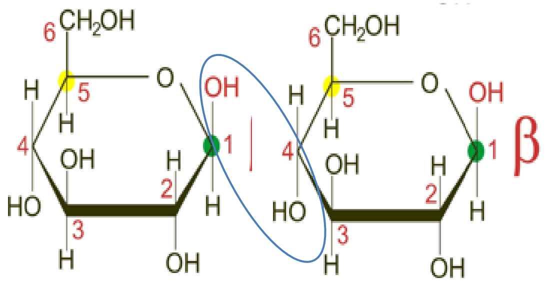
Glycogen

The presence of many terminal glucose molecules means that glucose can be rapidly hydrolysed giving quick access to stored energy.

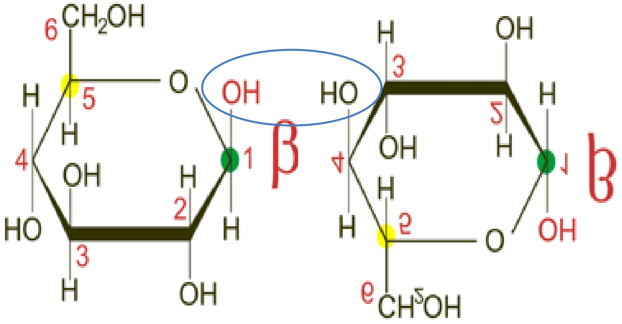
Cellulose is a **structural polysaccharide** made up of β-glucose which has an 'up' OH group on carbon 1 and a 'down' OH group on carbon 4.



Two adjacent β-glucose molecules cannot form a bond as the hydroxyl groups don't lie next to each other.



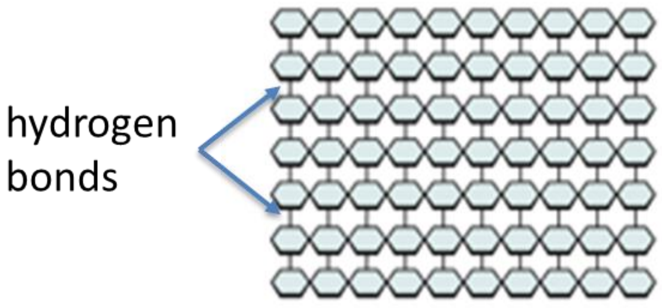
The only way to form a straight chain polymer is to 'flip' every other β-glucose through 180°



A 1,4 glycosidic bond can now form by using the adjacent hydroxyl groups. Water is formed by a condensation reaction.

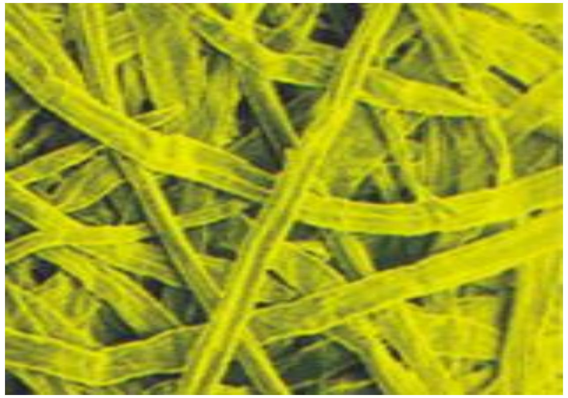
Cellulose is a straight chain polysaccharide of repeating β-glucose molecules joined by 1,4 glycosidic bonds only.

Cellulose strands are held together by hydrogen bonds forming a tough, insoluble structure.



Cellulose fibre

Cellulose is indigestible in the human gut and contributes to dietary fibre helping move material through the digestive tract.



Cellulose is the main component of cell walls in plants. Fibres of cellulose are laid down at different angles which further adds to its strength.